

THE FRUIT-FROST WORK OF THE WEATHER BUREAU IN THE UPPER SAN JOAQUIN VALLEY

634.1:551.574 (794)

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It is common knowledge that in the more important fruit-growing districts of California orchard heating for protection against frost damage is practiced more or less extensively. This is particularly true in the principal citrus producing sections. In recent years considerable interest has been aroused in the deciduous fruit sections in northern California, the interest usually arising in individual localities after a season of general frost damage followed by high prices. After each such season in late years there have been spasmodic preparations for heating of orchards, so that in the course of time most fruit growers have become acquainted in some measure with the theory and practice of orchard heating.

Inasmuch as orchard heating on many ranches involves measures which may be described as extraordinary—that is, altogether outside of the normal routine of the ranch work—the desirability of *preparedness* against frost was immediately recognized. The grower was quick to realize that dependable warnings of frost were essential to successful orchard heating on a large scale, and accordingly, at an early stage in the development of orchard heating in the deciduous-fruit sections of northern California, a plan of cooperation was worked out between the Weather Bureau and the county agents of the United States Department of Agriculture Extension Service for the issuance of frost warnings with widespread dissemination. By this plan, which was made applicable to any county on request of the extension service, and which has now been in operation for several years, the county agent arranges for advices of local weather conditions to be telegraphed to the district forecast center of the Weather Bureau at San Francisco each afternoon during the danger period. These local indications are given consideration by the district forecaster, who then prepares a frost warning which is telegraphed to the county agent for distribution. The warnings are also broadcast by several radiophone stations in the vicinity of San Francisco.

It was the experience of several of the county agents that as need for the forecasts developed over an ever-widening territory, attention to the details of the work and to local distribution made demands for their time such that the work became a real burden; in particular, local distribution of the forecasts required several hours of night work. Furthermore, it was soon found that additional refinement or localization of the general forecasts was desirable, work which would require the services of a professional meteorologist. For these reasons another plan was tried, first in Stanislaus County in 1926, by which a meteorologist of the Weather Bureau fruit-frost service would be assigned to the county during the period February 16–April 30 of each year to handle all details of the frost-warning service. This plan of operation was followed in Stanislaus County from that year to the present, and in 1929 the service was extended to two adjoining counties, San Joaquin and Merced, when it was found that this could conveniently be done. The Weather Bureau provides the fruit-frost service in these counties somewhat after the plan followed by the United States Department of Agriculture Extension Service in cooperating with the counties; that is, the Weather Bureau pays the salary of the meteorologist, provides the equipment, and bears the considerable

expense of telegraphic communications outside the counties, while the counties pay current operating expenses. Credit for securing the fruit-frost service for these counties is due mainly to the enterprise of the county agents now officiating—Messrs. Jungerman, Patton, and Quail, who secured from the boards of supervisors the necessary appropriations from county funds.

The benefits offered by this plan are, briefly, a localized frost-warning service with adequate distribution among the growers; an accurate and impartial temperature survey of the chief fruit-growing areas; and a personal advisory service for the growers on orchard-heating problems. As to its ultimate value to the community, it can be said that wherever the importance of fruit growing, with its attendant problem of orchard heating, has in the first instance warranted the fruit-frost service, the service provided has ordinarily proved so helpful to the growers that they request its continuance from year to year.

By some strange irony it happened that during the first three years of the service in Stanislaus County not one really damaging frost occurred, so that it became a standing jest among the growers that the county was paying the meteorologist Chinese fashion to prevent frost. While absence of killing frosts afforded much pleasure to the farmer, it proved no blessing to the fruit-frost service, for there was not the essential accumulation of data on damaging frosts for study. As events later proved, the work of forecasting for this new territory was made very difficult by the lack of such records for study and comparison. Considering, then, that during the first three years of the service there was apparently no need for it, it speaks well for the foresight of the county agents that not only was the service continued for the fourth consecutive year in Stanislaus County, but was extended to San Joaquin and Merced Counties as well. Their action was amply justified, for the spring of 1929 was one of the coldest on record, with a series of damaging frosts that took tremendous toll of nearly all varieties of fruit in the district.

It can be said with emphasis that the 1929 season was a stringent test for the fruit-frost service. The occurrence of the severest season in many years at the time when forecasts were made for new territory provided a combination of circumstances as unfavorable as ever likely to be encountered. It is well known to professional meteorologists that the method of forecasting minimum temperatures which has been found most successful in California utilizes an algebraic formula devised by F. D. Young for an original estimate which is modified by reference to prevailing weather conditions. Certain constants required by this formula are calculated from past records; hence it will readily be recognized that use of the formula without sufficient records of past frosts to calculate such constants was attended by no little uncertainty. Moreover, it was found that for a region without striking topographic differences the variations of minimum temperatures on a given morning were astounding. It was also observed, owing no doubt to the instability of the weather during the spring, that nocturnal winds or cloudiness could not invariably be forecast from the evening weather map; hence frosts did not always materialize when conditions seemed favorable. The conclusion inevitably follows, therefore, that while forecasting of the minimum temperatures in

this section will probably never achieve the accuracy attained in other sections, yet any failure is usually on the side of safety, and ample warning of frosts can be given. During the 1929 season no damaging frosts occurred without issuance of warnings to the growers sufficient to enable them to make needful preparations for the night.

This in itself should be considered a demonstration of the utility and feasibility of a frost-warning service, and it is not too much to say that the growers have profited from the service in the past to the extent that it may be considered indispensable in the future from their point of view.

WEATHER FORECASTS IN RELATION TO THE MARKETING OF CITRUS FRUITS

551.509:634.1

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Nearly all agricultural crops are subject to hazards of weather throughout their growing period, but the successful growing and marketing of citrus fruits depends to a large degree on the behavior of the weather throughout the entire year. Severe winter frosts sometimes destroy the greater part of the crop on the trees, and millions of dollars have been spent for frost protective devices. If unduly high day temperatures or low night temperatures occur within a day or two following the fumigation of orange trees for insect pests, much of the fruit is likely to fall to the ground, and the foliage often shows considerable injury. Unseasonably high temperatures in June, soon after the end of the blossoming period, often cause a heavy drop of small green fruits. Hot, dry, desert winds in some districts in California damage fruit and foliage nearly every year. Long continued periods of rain or dense fog sometimes stop orange-picking operations for days, or even weeks, and cause a heavy decay of fruits on the trees.

The Weather Bureau has been aiding the growers and packers of citrus fruits to ameliorate these difficulties as much as possible through forecasts of periods of adverse weather. Only recently, however, has much attention been paid to issuing forecasts to aid in meeting marketing problems caused by weather conditions.

It has long been recognized that lemon sales depend to a very great extent on summer temperatures in the districts where fruit is sold, and in recent years, since the consumption of orange juice has increased so materially, the sale of oranges has been similarly affected. There is a steady demand for lemons throughout the year for culinary and general purposes, but the use of lemons for beverage purposes takes place largely during the hot summer months. More than 50 per cent of the total yearly lemon sales are made during the period from May to August, inclusive.

Speculators buy and store lemons in the eastern marketing centers during the late spring to care for normal consumption during the early summer, but unusually high temperatures or long continued hot weather soon exhausts the supply, resulting in a shortage of fruit and abnormally high prices. There is practically always an adequate supply of lemons in storage at the packing houses in California, but it requires about 10 days for a car of fruit to reach the eastern markets, and individual periods of hot weather usually do not last more than a week. Forecasts of higher than normal summer temperatures in eastern markets made two or three days in advance permit the shipment of additional supplies of fruit from California to reach the markets before an acute shortage of lemons has developed, make possible the sale of a larger quantity of fruit, and maintain a more reasonable price to the consumer.

California had an unusually large crop of lemons to market during the summer of 1928. During the early part of June continued cool weather made it very difficult to move the crop in satisfactory volume and obtain fair prices. On June 27 the San Francisco forecaster advised the marketing agency in Los Angeles that temperatures above the seasonal normal were to be expected east of Mississippi River within a few days. On that date about 700 cars of lemons were on track in the East or en route. The market was declining, and it had been decided to reduce shipments from California until the market showed signs of improvement. On receipt of the forecast, shipments were continued without reduction. The effect of the hot wave was reflected almost immediately in the lemon market. On July 5, 184 cars of lemons were sold by the California Fruit Growers' Exchange, constituting the largest sales on any one day in the history of that organization. The price per box f. o. b. California averaged for all these cars \$4.73, the highest car-lot price since 1921, with the exception of 1923, when the price average was on only 28 carloads. The net return on these 184 cars of fruit was \$315,000. If shipments had been curtailed, as had been planned before the receipt of the forecast, less fruit would have been available for sale and the price to the consumer would have been much higher.

During the winter months cold waves or unusually heavy falls of snow in the eastern markets not only interfere with the movement of citrus fruits from California by rail, but also materially reduce the consumption of fruit. During periods of unusually cold weather in the winter of 1928-29 considerable fruit was frozen in the cars en route to market, and some important markets were closed entirely, due to heavy snow. No citrus fruit was unloaded in Chicago over a period of several days during one of the severest cold spells.

Forecasts of these cold waves in eastern territory enable the marketing agencies to hold entire trainloads of fruit in the warmer southern territory and at railroad division points, where the cars are kept in heated sheds until temperatures have moderated. The picking and packing of fruit in California is discontinued until the market has had time to recover from the demoralization caused by the low temperatures and heavy snow.

The writer believes that special forecasts of the type that have been described will prove to be of increasing value to many industries in the adjustment of marketing problems caused by weather conditions. This is a field for service of great practical value, and a field which is capable of much greater development, now that facilities for making more accurate forecasts for periods of several days are becoming available.